



# *Republic of South Africa*

## **EDICT OF GOVERNMENT**

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SANS 10238 (2011) (English): Welding and thermal cutting processes - Health and safety



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Edition 1.4

## **SOUTH AFRICAN NATIONAL STANDARD**

### **Welding and thermal cutting processes — Health and safety**

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**Table of changes**

<b>Change No.</b>	<b>Date</b>	<b>Scope</b>
Amdt 1	1994	Amended to clarify existing text and to insert additional provisions.
Amdt 2	1998	Amended to alter the requirements for hose holders.
Amdt 3	2005	Amended to update referenced standards and other publications, to insert a table on "threshold limit values for welding fume constituents", to change the numbering of two subclauses in clause 10, and to remove the introductory paragraph of annex A.
Amdt 4	2011	Amended to move reference to legislation to the foreword, update a referenced standard, modify a requirement for contractors, update the values of chromium (Cr3) and Manganese (Mn) in table 1, include a subclause on precautions for handling of thoriated tungsten electrodes and include a subclause on the electromagnetic field effects.

**Acknowledgement**

The SABS Standards Division wishes to acknowledge the valuable assistance derived from publications of the American Welding Society.

**Foreword**

This South African standard was approved by National Committee SABS TC 44, *Welding and allied processes*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

It is intended that this standard be used in conjunction with the Act as defined in clause 3.

This document was published in June 2011.

This document supersedes SANS 10238:2005 (edition 1.3).

A vertical line in the margin shows where the text has been technically modified by amendment No. 4.

Reference is made in clause 3, 3.1, 3.3, 3.8, 4.5, 5.2, 5.4, 6.1, 6.3.1, 6.10, 7.4, 11.3.1 and 12.2.2.1 to "relevant national legislation". In South Africa this means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) or the Mines and Works Act, 1956 (Act No. 27 of 1956), as applicable.

Annexes A and B are for information only.

## **Introduction**

Extensive investigations into the health and safety aspects of welding and cutting processes have been carried out since World War II, particularly in the United States. More recent studies carried out by the South African fabrication industry in collaboration with trade unions have revealed that conditions in the worker's environment, such as ventilation for adequate fume control, play a large part in the well-being of the professional welder.

Industrial hygienists and good management concern themselves with the worker's Threshold Limit Value (TLV) where work is carried out continually under arduous conditions.

This standard emphasizes the health and safety aspects of oxyfuel gas welding and arc welding processes, with some coverage given to the resistance welding, electron beam welding and laser beam welding processes. It contains information on protection of personnel and the work area, fire prevention and protection, confined spaces and the elimination of electrical hazards present in the arc welding process.

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## **Welding and thermal cutting processes — Health and safety**

### **1 Scope**

**1.1** This standard establishes the general principles for the protection of persons from injury and illness and for the protection of property and equipment from damage that can arise from welding and thermal cutting processes.

Specific provisions are included for oxyfuel gas welding, arc welding and resistance welding processes.

The standard also contains information useful to industrial hygienists, engineers and similar parties responsible for health and safety in all welding processes.

**1.2** This standard is applicable to all persons involved in welding and thermal cutting processes.

### **2 Normative references**

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

ANSI/NFPA 51B, *Fire prevention in use of cutting and welding processes*.

SANS 220, *Dissolved acetylene cylinders*.

SANS 275/EN 12083, *Respiratory protective devices – Filters with breathing hoses, (Non-mask mounted filters) – Particle filters, gas filters, and combined filters – Requirements, testing, marking*.  
Amdt 3

SANS 316 (SABS 316), *Industrial hand protectors (leather and fabric) and leather protective clothing*.

SANS 1156-2, *Hose for liquefied petroleum gas (LPG) – Part 2: Hose and tubing for use in LPG vapour phase and LPG-air installations*.

SANS 1186-1, *Symbolic safety signs – Part 1: Standard signs and general requirements*. Amdt 3

SANS 1237, *Single-stage low-pressure regulators for liquefied petroleum gas (LPG)*.

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SANS 1400, *Equipment (including oculars) for eye, face and neck protection against non-ionizing radiation arising during welding and similar operations – Welding helmets, hand shields, goggles and welding spectacles.*

SANS 1451-1, *Hearing protectors – Part 1: Ear-muffs.*

SANS 1451-2, *Hearing protectors – Part 2: Ear-plugs.*

SANS 3821/ISO 3821, *Gas welding equipment – Rubber hoses for welding, cutting and allied processes.* Amdt 3

SANS 10019, *Transportable containers for compressed, dissolved and liquefied gases – Basic design, manufacture, use and maintenance.*

SANS 10087-1, *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations – Part 1: Liquefied petroleum gas installations involving gas storage containers of individual water capacity not exceeding 500 L and a combined water capacity not exceeding 3 000 L per installation.*

SANS 10220, *The selection, use and maintenance of respiratory protective equipment.*

SANS 12941/EN 12941, *Respiratory protective devices – Powered filtering devices incorporating a helmet or a hood – Requirements, testing, marking.* Amdt 3

SANS 12942/EN 12942, *Respiratory protective devices – Power assisted filtering devices incorporating full face masks, half masks or quarter masks – Requirements, testing, marking.* Amdt 3

SANS 50143/EN 143, *Respiratory protective devices – Particle filters – Requirements, testing, marking.* Amdt 3

SANS 50149/EN 149, *Respiratory protective devices – Filtering half masks to protect against particles – Requirements, testing, marking.* Amdt 3

SANS 50405/EN 405, *Respiratory protective devices – Valved filtering half masks to protect against gases or gases and particles – Requirements, testing, marking.* Amdt 3

SANS 51827/EN 1827, *Respiratory protective devices – Half masks without inhalation valves and with separable filters to protect against gases or gases and particles or particles only – Requirements, testing, marking.* Amdt 3

SANS 54387/EN 14387, *Respiratory protective devices – Gas filter(s) and combined filter(s) – Requirements, testing, marking.* Amdt 3; amdt 4

| AWS Fact Sheet 16 – *Pacemakers and welding* (March 1997). Amdt 4

| AWS Fact Sheet 27 – *Thoriated Tungsten Electrodes* (Oct 2003). Amdt 4

## 3 Definitions

| For the purposes of this standard, the definitions given in the relevant national legislation (see foreword and 3.1) and the following definitions apply: Amdt 4

### 3.1 Act

| relevant national legislation (see foreword) Amdt 4

**3.2****approved/approval**

- approved by, or approval of, the Chief Inspector of the Department of Manpower or the Director General of the Department of Mineral and Energy Affairs; or Amdt 1
- that meets nationally recognized standards as per annex B; or
- that has been tested to a nationally recognized standard, found safe for use and approved by a competent person

**3.3****competent person**

a person as defined in the regulations promulgated in terms of the relevant national legislation (see foreword) Amdt 4

**3.4****confined space**

a restricted space such as a tank, boiler, pressure vessel or small compartment. Confinement implies poor ventilation as a result of construction, size or shape rather than restriction of egress of personnel

**3.5****cutting**

the cutting of metals by means of heat, with or without a stream of oxygen

**3.6****cylinder storage**

cylinders of compressed gas standing by on the site (not including those in use or attached ready for use)

**3.7****designated area**

a work area that has been allocated for a specific purpose

**3.8****engineer**

a certificated engineer, as defined in the regulations promulgated in terms of the relevant national legislation (see foreword) Amdt 4

**3.9****fuel gas**

any combustible gas

Amdt 1

**3.10****fume**

all airborne pollutants including dust, particulate matter and pollutant gases arising from welding and thermal cutting processes Amdt 1

**3.11****hotwork**

any work involving burning, welding, cutting or similar heat-producing operations

Amdt 1

**3.12****surfacing**

the deposition of a layer of metal on a metallic substrate by a process involving heat

**3.13**

**threshold limit value**

**TLV**

the level of airborne concentrations of substances and the conditions to which a worker can be repeatedly exposed without adverse effect

**3.14**

**TLV-ceiling**

**TLV-C**

the level of concentration of contaminants that shall not be exceeded during any period of the working exposure

**3.15**

**TLV-short-term exposure limit**

**TLV-STEL**

the level of concentration of contaminants to which workers can be exposed continuously for a maximum period of 15 min, without injurious effect, provided that the daily TLV-TWA is not exceeded and that these TLV-short-term exposures do not occur more than four times per day

**3.16**

**TLV-time-weighted average**

**TLV-TWA**

the time-weighted average concentration of contaminants in a normal 8 h workday and a 40 h workweek, to which most workers can be exposed, day after day, without any adverse effect

**3.17**

**welder and welding operator**

any operator of electric or oxyfuel gas welding or thermal cutting equipment

**3.18**

**welding booth**

an area, demarcated by non-combustible or flame-resistant screens, used for the express purpose of welding, cutting and allied processes

**3.19**

**worker's breathing zone**

a spatial hemisphere of radius 300 mm, extending in front of the worker's face and measured from the centre of an imaginary straight line joining the ears

## **4 Responsibilities**

### **4.1 Management**

#### **4.1.1 Training**

Management shall ensure that welders and their supervisors are trained in the safe operation of the equipment, the safe use of the welding processes and workshop emergency procedures.

Management shall ensure that the hazards involved in the use of welding consumables are identified and communicated to the welder and that due cognizance is taken of the safety precautions recommended by the manufacturer of such consumables.

#### **4.1.2 Safety procedures in non-designated areas**

Management shall establish safety procedures for welding and cutting and shall designate a responsible person to authorize, and be responsible for, welding and cutting operations in areas not specifically designated or approved for such purposes.

**Amdt 1**

#### **4.1.3 Contractors**

Management shall select contractors employing welders qualified in terms of the applicable approved welding codes, specifications and standards. Management shall advise contractors of any flammable materials or hazardous conditions of which the contractor may be unaware. **Amdt 4**

### **4.2 Equipment**

#### **4.2.1 Approved equipment**

Management shall ensure that equipment, such as welding torches, manifolds, regulators, pressure-reducing valves, acetylene generators, welding machines, electrode holders and personnel protective clothing, is used for its intended purpose only.

#### **4.2.2 Equipment operation**

All equipment shall be operated in accordance with the manufacturer's recommendations and instructions.

#### **4.2.3 Equipment maintenance**

All welding and cutting equipment shall be maintained in good working order and inspected on a monthly basis and, when found to be defective (incapable of reliable, safe operation), shall be promptly repaired or withdrawn from service. **Amdt 1**

NOTE The above does not preclude users of welding and cutting equipment from carrying out normal inspections in terms of general safety precautions. **Amdt 1**

### **4.3 Supervisors**

#### **4.3.1 Safe use of equipment**

Supervisors shall be responsible for the safe handling of the welding equipment required for the specific welding process.

#### **4.3.2 Combustibles**

Supervisors shall determine what combustible materials and hazardous areas are present or likely to be present in the workplace. They shall take the following actions to ensure that combustibles are not exposed to ignition:

- a) have the work moved to a location free from combustibles or away from hazardous areas; or
- b) have the combustibles moved to a safe distance from the workplace or properly shielded against ignition.

#### **4.3.3 Protective equipment and fire protection**

Supervisors shall ensure that appropriate protective equipment is used. They shall ensure that the correct fire-protection and fire-extinguishing equipment is properly located at the site, and that hot work authorization procedures are followed (see 7.3 and 7.4).

Within half an hour after the completion of welding operations the supervisor shall carry out a final inspection of the site to detect and extinguish possible smouldering fires (see 7.3.2).

## **4.4 Welding operators**

### **4.4.1 Safe handling of equipment**

Welding operators shall ensure that they are aware of the hazards of the operation to be performed and the procedures that are used to control hazardous conditions. They shall handle the equipment safely so as not to endanger lives and property.

### **4.4.2 Warning of hot materials**

Where personnel can come into contact with hot material resulting from welding or cutting operations, a warning notice shall be displayed.

## **4.5 First-aid and emergency procedures**

Management shall ensure that all first-aid equipment and emergency procedures are in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword).

**Amdt 4**

## **5 Protection of the general area and personnel**

### **5.1 Protection of the general area**

#### **5.1.1 Equipment**

Welding equipment, machines, cables and other apparatus shall be so situated that they do not present a hazard to personnel in passageways, on ladders or on stairways. Good housekeeping shall be maintained at all times.

#### **5.1.2 Warning signs**

Warning signs shall be posted designating welding areas and indicating that eye protection shall be worn.

#### **5.1.3 Protective screens**

Where operations permit, welders or other persons adjacent to the welding areas shall be protected from the radiant energy and spatter of welding and cutting arcs by non-combustible or flame-resistant screens or shields, or shall be required to wear suitable eye/face protection and protective clothing. The use of approved radiation-protective, semi-transparent materials is permissible. Booths and screens shall permit circulation of air at floor level and above the screens.

Where arc welding is carried out regularly adjacent to painted walls, the walls shall be finished with a paint that has low reflectivity to ultraviolet radiation.

NOTE Finishes formulated with pigments such as titanium dioxide or zinc oxides have low reflectivity to ultraviolet radiation. Colour pigments may be added if they do not increase reflectivity.

### **5.2 Eye and face protection**

Eye and face protection shall comply with the regulations promulgated in terms of the relevant national legislation (see foreword).

**Amdt 4**

## **5.2.1 Types of protection required**

### **5.2.1.1 Protection during open arc welding and cutting**

Welding operators, helpers and personnel viewing the arc area shall be provided with helmets or handshields fitted with the appropriate filter. Other personnel working within the welding area shall be provided with safety goggles or spectacles with side shields. Goggles used as protection during open arc welding and cutting shall be vented to deter fogging of the lenses. Ventilation of cup-type goggles shall be baffled to prevent the passage of light rays into the interior of the eyecup.

### **5.2.1.2 Protection during resistance welding or brazing**

Operators of resistance welding or brazing equipment and their helpers shall use face shields, safety spectacles or goggles.

### **5.2.1.3 Protection in large viewing areas**

In the case of large viewing areas such as for training, demonstrations and certain automatic welding operations, a large filter window or curtain may be used instead of individual helmets, handshields or goggles. The window or curtain material shall have a maximum transmittance of 1 % below 500 nm wavelength and shall be at least 1 m from the arc. In addition, approved arrangements shall be provided to protect viewers from sparks and chipped slag.

## **5.2.2 Requirements for eye and face protection**

### **5.2.2.1 Helmet and handshield shells**

Helmet and handshield shells shall comply with the applicable requirements of SANS 1400.

### **5.2.2.2 Filter covers**

Filter covers shall be provided to protect the filter lens or filter plate in goggles, helmets or handshields from welding spatter, pitting or scratching. Filter covers shall be of clear glass or self-extinguishing plastics, but need not be impact resistant.

### **5.2.2.3 Filters**

All filters shall comply with the requirements of SANS 1400.

### **5.2.2.4 Eyeshields**

When the "lift front" type of welder's helmet is used, there shall be a fixed impact-resistant eyeshield on the inside of the frame, in accordance with SANS 1400.

### **5.2.2.5 Marking of lenses and plates**

Filter lenses and plates shall bear a permanent distinctive marking by which the manufacturer and shade number can be readily identified (see SANS 1400).

### **5.2.2.6 Maintenance**

Helmets, handshields and goggles shall be well maintained (see 4.2.3) and should not be transferred from one employee to another without having been cleaned and disinfected. **Amdt 1**

## **5.3 Protective clothing**

### **5.3.1 General**

Protective clothing for any welding and cutting operation will vary with the size, nature and location of the work to be performed. Clothing shall be in accordance with the requirements of SANS 316.

All outer clothing such as overalls shall be free from oil and grease. Cotton clothing, if used for protection, shall be chemically treated to reduce its combustibility. Clothing treated with non-durable flame-resistant materials shall be retreated after each wetting or cleaning. Materials that can melt and cause severe burns shall not be used as protective clothing near welding areas.

**NOTE** It is recommended that sleeves, collars and, where possible, pockets be kept buttoned. Front pockets should be emptied of flammable or readily combustible materials. Trousers or overalls should not have cuffs and should not be turned up on the outside. Trousers should overlap shoe tops to prevent spatter from getting into shoes. Frayed clothing is particularly susceptible to ignition and burning and should not be worn during welding or cutting operations.

### **5.3.2 Gloves**

Gloves shall be used to protect the hands and wrists. Insulated linings shall be used to protect hands exposed to high radiant energy.

### **5.3.3 Aprons**

Appropriate aprons to protect the front of the body shall be used at all times when welding and cutting equipment is used.

**Amdt 1**

### **5.3.4 Leg guards**

Flame-resistant leg guards shall be used to give added protection to the legs and feet. In production work, a sheet metal screen in front of the welder's legs can provide further protection against sparks and molten metal during cutting operations.

### **5.3.5 Welder's yokes**

Welder's yokes or shoulder covers with bibs shall be worn during overhead welding or cutting.

### **5.3.6 Other protective clothing**

Flame-resistant ear plugs or equivalent protection shall be used where noise hazards exist (see 5.4).

Caps made from a flame-resistant material shall be worn under helmets to prevent head burns.

## **5.4 Noise**

Noise shall be controlled at the source if this is feasible. Measurement and assessment of noise shall comply with the regulations promulgated in terms of the relevant national legislation (see foreword). When control methods fail to bring noise levels to within the permissible limits, personal protective devices such as ear muffs or ear plugs that comply with SANS 1451-1 or SANS 1451-2, as relevant, shall be provided and a hearing conservation programme implemented.

**Amdt 1; amdt 4**

## **6 Ventilation**

### **6.1 Adequate ventilation**

Adequate ventilation (natural or mechanical) shall be provided for all welding, cutting, brazing and related processes, in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword). Amdt 4

Welders and cutting personnel shall take precautions to avoid breathing the fume plume directly. This can be accomplished by the positioning of the work or by ventilation that directs the plume away from the welder's face.

### **6.2 Types of ventilation**

#### **6.2.1 Natural ventilation**

Natural ventilation is acceptable for welding, cutting, brazing and related processes if the necessary precautions are taken to keep the plume away from the welder's breathing zone and if sampling of the atmosphere shows that the concentration of contaminants is below the threshold limit values (TLVs) given in table 1. Amdt 3

#### **6.2.2 Mechanical ventilation**

If natural ventilation is not sufficient to maintain the concentration of contaminants below the TLVs given in table 1, mechanical ventilation or respirators shall be provided. Amdt 3

### **6.3 Special ventilation considerations**

#### **6.3.1 Confined spaces**

Before they are entered, confined spaces shall be tested in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword). Amdt 1; amdt 4

**6.3.2** Deleted by amendment No. 1.

**6.3.3** Deleted by amendment No. 1.

#### **6.3.4 Air quality and quantity**

Only clean respirable air shall be used for ventilation. The quality and quantity of air for ventilation shall be such that personnel exposures to hazardous contaminants are maintained below the limits specified in table 1. Amdt 3

The compressed air line for respirators should be a single-purpose line that is not capable of being connected to any other line that could allow hazardous or toxic gases into the respirator air line. Air may be natural air or synthesized air for breathing purposes.

**Table 1 — Threshold limit values for welding fume constituents**

1	2	1	3
Element	TLV-TWA mg/m <sup>3</sup>	Element	TLV-TWA mg/m <sup>3</sup>
Aluminium (Al)	5,0	Iron (Fe)	5,0
Antimony (Sb)	0,5	Lead (Pb)	0,15
Arsenic (As)	0,2	Magnesium oxide fume	10,0
Barium (Ba)	0,5	Manganese (Mn)	0,5
Beryllium (Be)	0,002 [A2]	Mercury (Hg)	0,01 to 0,1
Boron oxide	10,0	Molybdenum (Mo)	5,0
Boron trifluoride	2,8 [C]	Nickel (Ni)	1 [A2]
Cadmium (Cd)	0,05 [C]	Nitrogen dioxide	5,6 9,4 <sup>a</sup>
Calcium oxide	2,0	Ozone (O <sub>3</sub> )	0,2 [C]
Carbon dioxide	9 000 54 000 <sup>a</sup>	Phosgene	0,4
Carbon monoxide	57 458 <sup>a</sup>	Phosphoric acid	1,0
Chlorine dioxide	0,28 0,83 <sup>a</sup>	Selenium (Se)	0,2
Chromium (Cr3)	0,50	Silver (Ag)	0,01 to 0,1
Chromium (Cr6)	0,05 [A1]	Tin oxide fume	2,0
Cobalt	0,05	Titanium dioxide	10,0
Copper (Cu)	0,2	Tungsten and compounds	1,0 to 5,0
Fluoride (F)	2,5	Vanadium (V) (respirable)	0,05
Fluorine	1,6 3,1 <sup>a</sup>	Welding fume (NOC)	5,0 [B2]
Indium (In)	0,1	Zinc (Zn)	5,0

NOTE 1 Excursions in exposure levels can exceed three times the TLV-TWA but such excursions shall be limited to a maximum of 30 min during any working period. Excursions up to a maximum of five times the TLV-TWA are permitted provided that the total TLV-TWA for the working period is not exceeded.

NOTE 2 [A1] and [A2] refer to the classification of carcinogenic materials. [B2] identifies substances of variable composition. [C] refers to ceiling values. NOC refers to substances which are not otherwise classified.

<sup>a</sup> Short-term exposure limit (STEL).

Amdt 3; amdt 4

### 6.3.5 Prohibited ventilation gases

Only air shall be used for ventilation. Oxygen, or any other gas or mixtures of gases, shall not be used.

### 6.3.6 Ventilation in areas dangerous to life and health

Areas immediately dangerous to life or health are those areas where it is known that the atmosphere cannot safely sustain life or health. When welding, cutting or related processes are

performed in areas immediately dangerous to life or health, positive-pressure self-contained breathing apparatus or airline respirators shall be used. Each of these shall have an emergency self-contained air supply of at least 5 min duration in the event of failure of the main source.

Adequate ventilation shall be ensured not only to protect welders or cutters themselves, but to protect all personnel who are present in the area.

### **6.3.7 Precautions for handling of thoriated tungsten electrodes**

Thoriated tungsten non-consumable electrodes contain a low-level radioactive material named thorium that may cause radioactive contamination to weld personnel by inhalation or ingestion. The use of thoriated tungsten electrodes should therefore be avoided where practically possible due to the inherent radiation hazard. Instead use electrodes with less harmful additions such as a lanthanum or cerium.

Dressing of thoriated electrodes should only be conducted with the necessary respiratory precautions such as dust extractors with special filtration in place to prevent inhalation of thoriated tungsten dust. (See AWS Fact Sheet 27 for more detailed information). Amdt 4

## **6.4 Location of service equipment**

**NOTE** The purpose of this provision is to prevent contamination of the atmosphere of a confined space by possible leaks from gas cylinders or fumes from welding power sources or similar equipment.

### **6.4.1 Compressed gas cylinders and welding power sources**

When welding or cutting is being undertaken in confined spaces, gas cylinders and welding power sources shall be located outside the confined space.

### **6.4.2 Heavy portable equipment on wheels**

Before operations are started in a confined space, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

### **6.4.3 Ventilation ducts**

Ducts used to provide local exhaust ventilation for welding, cutting, brazing and related processes shall be constructed of non-combustible materials. These ducts shall be inspected as necessary to ensure proper function and that the internal surfaces are free of combustible residuals.

The company's management procedures shall stipulate that inspection and testing of ventilated ducts are to be carried out in accordance with the requirements of a relevant approved standard. Amdt 1

## **6.5 Adjacent areas**

When welding or cutting is to be done over or adjacent to any confined space, personnel shall be made aware of the respiratory hazards in the confined space and shall not enter such spaces without taking the necessary precautions (see 6.3.1). Amdt 1

**6.6** Deleted by amendment No. 1.

**6.7** Deleted by amendment No. 1.

## **6.8 Brazing furnaces**

Brazing furnaces are in many respects a type of confined space. They use a variety of atmospheres to exclude oxygen during the brazing process. Such atmospheres may include inert gas, flammable gas, flammable gas combustion products, or vacuum. Potential hazards in the operation of brazing furnaces are the following:

- a) asphyxiation of personnel entering or working in adjacent areas where there is insufficient oxygen in the atmosphere to support life;
- b) development of explosive mixtures of flammable gas and air within the furnace during generation or venting of atmosphere within the furnace; and
- c) accumulation of hazardous fumes or gases in the work area due to the brazing process.

In all cases, adequate mechanical ventilation shall be provided to remove all explosive or toxic gases that may emanate from furnace purging and brazing operations. Where complete combustion takes place in or at the furnace during the heating cycle, the requirements can diminish.

### **6.8.1 Life support**

If personnel are required to enter the brazing furnace, or the adjacent areas, the provisions of 6.1 shall be observed.

### **6.8.2 Fire and explosion**

If brazing furnaces utilize a flammable gas for their interior atmosphere, or if a flammable gas is burned to create an interior atmosphere, procedures shall be followed to ensure that an explosive mixture of flammable gas and air is not produced in the furnaces.

### **6.8.3 Venting**

Venting of the atmosphere within brazing furnaces shall be such that the atmosphere is exhausted to a location where it will not constitute a danger to personnel near the location.

## **6.9 Respiratory protective equipment**

When ventilation controls fail to reduce air contaminants to allowable levels or when the implementation of such controls is not feasible, respiratory protective equipment complying with the requirements of SANS 54387, SANS 275, SANS 12941, SANS 12942, SANS 50405, SANS 50143, SANS 50149, SANS 51827 as applicable and SANS 10220 shall be used to protect personnel from hazardous concentrations of airborne contaminants.

**Amdt 3; amdt 4**

## **6.10 Asbestos**

If welding or cutting is to be carried out on surfaces that are covered with asbestos insulation, the regulations promulgated in terms of the relevant national legislation (see foreword) shall be applied.

**Amdt 4**

# **7 Fire prevention and protection**

## **7.1 General**

For more information on the following precautions, and also on the fire prevention and protection responsibilities of welders, supervisors (including outside contractors) and management, reference should be made to ANSI/NFPA 51B.

## **7.2 Areas containing combustibles**

### **7.2.1 Conditions for welding or cutting**

No welding or cutting shall be carried out unless the atmosphere is non-flammable and any combustibles or easily vaporized chemical agents have been moved away or protected from possible ignition or heating.

### **7.2.2 Welding or cutting near combustibles**

When welding or cutting is carried out near combustibles, non-flammable guards shall be used to protect the combustibles from heat, sparks, spatter and chipped slag.

## **7.3 Fire protection**

### **7.3.1 Extinguishers and sprinklers**

Appropriate fire-extinguishing equipment shall be ready for use where welding and cutting operations are being carried out, depending upon the nature and quantity of the combustible material exposed. Where sprinkler system protection exists, it shall remain operable during the welding or cutting. Automatic sprinkler heads immediately overhead of the welding or cutting operation can, if necessary, be temporarily shielded with non-combustible sheet material or damp cloth guards.

### **7.3.2 Fire prevention**

Where so required, competent persons shall be assigned to work with welders to extinguish any fires resulting from welding and cutting operations.

They shall watch for fires in all exposed areas, try to extinguish them only when the fires are within the capacity of the fire-extinguishing equipment available, or otherwise sound the alarm. A fire watch shall be maintained for at least half an hour after completion of welding or cutting operations in order that possible smouldering fires may be detected and extinguished, and this shall be followed by a final inspection by the supervisor. The competent person shall watch for fires in areas not readily observable by the welder, such as the other side of walls or partitions.

Competent persons who are assigned duties to detect and prevent the spread of fires shall be trained in the relevant fire-reporting procedures, the use of fire-extinguishing equipment and emergency rescue procedures. They shall remain outside any confined space and shall be in communication with any workers within the confined space.

## **7.4 Hotwork authorization**

Before welding or cutting operations are carried out in locations not designed for such purposes, inspection shall be undertaken by, and authorization in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword) shall be obtained from a responsible person.

**Amdt 1; amdt 4**

## **7.5 Welding or cutting of containers that have held flammables**

Before the welding or cutting of containers (which include jacketed vessels, tanks, or other similar items) that have held flammable materials, the containers shall have been cleaned in accordance with the requirements of a relevant approved standard.

**Amdt 1**

## **8 Public exhibitions/demonstrations**

In addition to the general safety precautions outlined in clause 7, the precautions referred to in this clause shall be provided for the protection of the general public attending welding exhibits and demonstrations.

### **8.1 Public safety**

The general public shall be protected from all welding hazards in accordance with the provisions.

**Amdt 1**

### **8.2 Site**

#### **8.2.1 Site locations**

Materials and equipment on the site shall be so located as to not interfere with the evacuation of people during an emergency.

#### **8.2.2 Site design**

The site shall be so constructed, equipped and operated as to minimize the possibility of injury to viewers at the site.

The public shall be protected from inhaling hazardous concentrations of fumes and gases.

## **9 Cautionary labelling**

### **9.1 General**

Welding and cutting operations pose hazards with regard to fumes, gases, electric shock, heat, radiation and noise. The public should be warned against these hazards by means of adequate cautionary labelling. Examples of recommended labels are given in SANS 1186-1.

**Amdt 3**

### **9.2 Labelling for oxyfuel gas welding and arc welding processes and equipment**

The appropriate labels given in SANS 1186-1 should be placed on containers of stock materials such as wires, fluxes and electrodes and on major equipment such as power supplies, wire feeders and controls used in arc welding, arc cutting and allied processes. The information should be clearly visible and may be on a label, tag or other printed form.

**Amdt 3**

Additional precautionary measures can be added as appropriate for special requirements.

### **9.3 Labelling for hazardous materials**

A number of potentially hazardous materials are used in the fluxes, coatings, covering and filler metals used in welding and cutting, or are released to the atmosphere during welding and cutting. Each component of a potentially hazardous material shall be identified on the up-to-date Material Safety Data Sheet (MSDS), which should be available from the manufacturer on request.

**Amdt 1**

The manufacturer shall be responsible for ensuring that the consumer is informed of any revision to an existing MSDS.

**Amdt 1**

#### **9.4 Labelling for brazing filler metals containing cadmium**

Brazing filler metals containing cadmium as a designated constituent should carry the relevant information on tags, boxes or other containers and on any coils of wire not supplied to the user in a labelled container. Cadmium is one of the more hazardous ingredients of filler metals and should be prominently labelled as such.

#### **9.5 Labelling for brazing and gas welding fluxes containing fluorides**

Containers of brazing and gas welding fluxes containing fluorine compounds should have labels or tags carrying cautionary information indicating that the contents contain fluorine compounds.

#### **9.6 Graphic symbols on labels**

Graphic symbols may be used to supplement part of the cautionary information on the label.

### **10 Oxyfuel gas welding and cutting safety**

#### **10.1 Terminology**

To prevent possible misunderstanding or misinterpretation, all combustible gases shall be referred to as "fuel gases" and not just by the word "gas". Use of the proper name is required to ensure that the correct fuel gas is used for a particular application.

#### **10.2 Oxygen and combustibles**

##### **Keep oxygen away from combustibles**

Oxygen cylinders, cylinder valves, couplings, regulators, hoses, etc., shall be kept free from oil, grease, hydrocarbons and other flammable or explosive substances. Oxygen cylinders or equipment shall not be handled with oily hands or oily gloves.

#### **10.3 Prohibited uses of oxygen**

##### **10.3.1 General**

**Amdt 3**

Oxygen shall not be used as a substitute for compressed air. Oxygen shall not be used in pneumatic tools, in oil preheating burners, to start internal combustion engines, to blow out pipelines, to dust off clothing or work, or to create pressure for ventilation or similar applications. Jets of oxygen shall not be directed towards an oily surface, greasy clothing, or enter fuel oil or other storage tanks.

##### **10.3.2 Oxygen equipment**

**Amdt 3**

Oxygen cylinders, equipment, pipelines or apparatus shall not be used for any other gas.

#### **10.4 Attachments for gas mixing**

No device or attachment that facilitates or permits the mixing of air or oxygen with flammable gases, (except at a burner or in a torch) shall be allowed, unless the device or attachment is specifically designed for this purpose.

## **10.5 Torches**

### **10.5.1 Approval**

Only approved torches shall be used.

### **10.5.2 Operation**

#### **10.5.2.1 Leak testing of connections**

Connections shall be checked for gastightness after assembly and before the torch is lit. Flames shall not be used. Safe leak test solutions for use on oxygen and fuel gas connections are commercially available and shall be used.

**Amdt 1**

#### **10.5.2.2 Purging hoses**

Before the torch is lit, hoses shall be purged individually. This consists of allowing each gas to flow through its respective hose separately for long enough to purge out any flammable gas mixture in the hose. Hoses shall not be purged into confined spaces or near ignition sources.

#### **10.5.2.3 Lighting the torch**

A friction lighter, stationary pilot flame, or other suitable source of ignition shall be used to light the torch. Matches or cigarette lighters shall not be used for lighting torches; under no circumstances should a torch be lit or relit from hot metal. The torch shall be pointed away from persons or combustible materials.

The manufacturer's procedures shall be followed with respect to the sequence of operations in lighting a torch and in adjusting and extinguishing its flames.

#### **10.5.2.4 Confined space**

To minimize the possibility of gas accumulation in confined spaces because of leaks or improperly closed valves after gas welding or cutting has been completed, the torch valves shall be closed and, in addition, the fuel gas and oxygen supply to the torch shall be positively shut off at a point outside the confined space. Whenever a torch is not going to be used for a substantial period of time, such as during lunch or overnight, the torch and hose shall be removed from the confined space. (See also clause 6 for other precautions to be observed during welding operations in confined spaces.)

## **10.6 Hose and hose couplings**

### **10.6.1 Specifications**

Hose and the colours of hose used for oxyfuel gas welding and cutting shall comply with the requirements of SANS 3821 and SANS 1156-2, as applicable.

**Amdt 3**

**NOTE** The use of metal-clad or armoured hose is not recommended. When conditions of use make metal reinforcing advantageous, such hose may be used if the metal reinforcing is not exposed to the gases inside the work area or to the outdoor atmosphere, unless the hose is specifically designed for use with oxyfuel gas.

### **10.6.2 Hose holders**

Hoses shall not be tied together with cable ties, tapes or any other form of lashing. When parallel lengths of hose are held together for convenience, only suitable metal or plastics hose holders shall be used.

**Amdt 2**

Suitable hose holders are holders that

- a) hold the hoses together in a neat and tidy way, Amdt 2
- b) are so constructed that the hoses are held together securely but can easily be separated when required, Amdt 2
- c) are so constructed that a gap can be maintained between the hoses to allow sparks to fall through, and Amdt 2
- d) have no sharp edges that could harm personnel or the hoses. Amdt 2

### **10.6.3 Maintenance**

Upon inspection, hose showing signs of burns, wear or other defects shall be replaced. Frequency of inspection depends upon the amount and severity of use. Amdt 1

### **10.6.4 Hose couplings**

Hose couplings shall comply with the approved standard (see table A.1) as regards left-hand threads for fuel gas and right-hand threads for other gases.

Hose couplings for welding gas lines shall not be compatible with couplings for breathing air.

Hoses shall only be connected or extended in length with purpose-designed fittings. Under no circumstances shall copper or steel tubing be used.

### **10.6.5 Devices**

When an approved device such as a hose check valve, flashback arrestor or quick coupling is used in an oxyfuel gas welding and cutting torch system, the device shall be used and maintained in accordance with the manufacturer's instructions.

### **10.6.6 Safety devices**

In all instances where oxyfuel gas equipment (including air fuel gas) is used, suitable flashback arrestors shall be fitted in accordance with the manufacturer's instructions.

## **10.7 Pressure-reducing regulators**

### **10.7.1 Approval**

Only approved pressure-reducing regulators shall be used.

### **10.7.2 Liquefied petroleum gas (LPG) regulators**

LPG regulators shall comply with the requirements of SANS 1237.

### **10.7.3 Designated service**

Pressure-reducing regulators shall be used only for the gas and pressures for which they are labelled. The regulator inlet connections shall comply with the relevant provisions of SANS 10019.

Regulators shall not be interchanged among designated gas services.

#### **10.7.4 Inspection before use**

Union nuts and connections on regulators shall be inspected before use to detect faulty seats that may cause leakage when the regulators are attached to cylinder valves or hoses. Damaged nuts or connections shall be replaced.

#### **10.7.5 Oxygen pressure gauges**

Pressure gauges used for oxygen service shall be marked with the words "USE NO OIL" or the approved pictogram.

#### **10.7.6 Regulators**

Before regulators are attached to a cylinder or manifold, the pressure-adjusting screw shall be released.

The cylinder or manifold outlet connection shall be wiped with a clean cloth free of oil and lint, and the cylinder valve "snifted" by being opened momentarily to remove any contaminants and then immediately closed before the regulator is connected (see 10.8.4.3).

Cylinder or manifold valves shall always be opened slowly (see 10.8.4.4).

#### **10.7.7 Repairs**

When equipment or parts thereof need repair, the work shall be performed by a person competent to do such repair work.

**Amdt 1**

### **10.8 Gas cylinders**

**NOTE** Compressed gas cylinders used in welding and cutting processes generally contain gases at pressures up to 20 000 kPa. Gases at these pressures are dangerous if not correctly handled. The procedures described in this clause are intended to prevent damage to or abuse of gas cylinders which might cause them to leak or explode, resulting in damage, injury or death.

#### **10.8.1 General provisions**

##### **10.8.1.1 Approval**

All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with SANS 10019.

Such compliance shall be recognized by markings on the cylinder, usually on the shoulder.

##### **10.8.1.2 Filling authorization**

No person other than an authorized filling agent shall fill a cylinder.

##### **10.8.1.3 Mixing of gases**

No person other than the gas supplier shall mix gases in a cylinder.

##### **10.8.1.4 Content identification**

Compressed gas cylinders shall be legibly marked in conformance with SANS 10019 and SANS 220 with either the chemical or the trade name of the gas for the purpose of identifying the gas content.

Cylinders the contents of which are not identifiable, shall not be used and shall be returned to the supplier.

#### **10.8.1.5 Changing of markings**

The numbers and markings stamped onto cylinders shall not be changed in any manner.

#### **10.8.1.6 Connection threads**

Compressed gas cylinders shall be equipped with connections that comply with the appropriate provisions of SANS 10019.

#### **10.8.1.7 Valve protection**

All cylinders manufactured after 1985 and with a water capacity exceeding 10 L shall be equipped with a means of fitting a valve protection cap or with a collar to take a guard or a recess to protect the valve. All fuel gas or poisonous gas cylinders, irrespective of water capacity, shall have the valve protected against damage.

#### **10.8.1.8 Cylinder temperature**

The temperature of the cylinder contents shall not exceed 65 °C.

#### **10.8.1.9 Damaged cylinders**

Cylinders suffering from severe damage, corrosion or exposure to fire shall be destroyed in an approved manner.

**Amdt 1**

### **10.8.2 Cylinder storage**

#### **10.8.2.1 Protection**

Cylinders shall be stored where they will not be exposed to physical damage, to tampering by unauthorized persons, or to temperatures that would raise the contents above the limit given in 10.8.1.8.

Cylinders shall be stored in assigned places away from pathways, elevators, stairs or gangways in locations where they will not be damaged by passing or falling objects. Cylinders in storage shall be adequately secured to prevent falling. Fuel gas cylinders shall not be stored within 1 m of an electric power point.

#### **10.8.2.2 Cylinders separated from combustibles**

Cylinders in storage shall be separated from flammable and combustible liquids and from easily ignited materials (such as wood, paper, packaging materials, oil and grease) by means of a non-combustible barrier of height at least 1,6 m and that is fire resistant for at least half an hour, or shall be stored at least 5 m away from such combustible materials.

#### **10.8.2.3 Oxygen separated from fuel gas**

Oxygen cylinders in storage shall be separated from fuel gas cylinders, by means of a barrier similar to that described in 10.8.2.2.

#### **10.8.2.4 Fuel gas cylinders**

Acetylene and liquefied gas cylinders shall be stored upright and shall not be in direct sunlight.

#### **10.8.2.5 Fuel gas storage**

Fuel gas storage shall be approved by the local fire prevention officer in accordance with the provisions of SANS 10087-1.

**Amdt 1**

### **10.8.3 Cylinder handling**

#### **10.8.3.1 Rough handling**

Cylinders shall not be dropped, struck or permitted to strike objects violently in a manner that could damage the cylinder, the valve or the safety devices.

#### **10.8.3.2 Rollers or supports**

Cylinders shall never be used as rollers or supports.

#### **10.8.3.3 Cylinder safety devices**

Cylinder safety devices shall not be tampered with in any way.

#### **10.8.3.4 Valves**

Cylinder shut-off valves shall be closed before cylinders are moved.

#### **10.8.3.5 Valve protection**

In most cases, valve guards are provided as protection. Where a cylinder is designed to accept a valve protection cap, the cap shall always be in place and handtight (except when cylinders are in use or connected for use). Cylinder valve protection caps shall be kept with the cylinders so that they can be reassembled when the regulator is removed.

#### **10.8.3.6 Manual lifting**

Valve guards, when specifically designed and fitted for the purpose of lifting, may be used for the transporting of cylinders. Valve protection caps shall not be used for lifting cylinders.

#### **10.8.3.7 Lifting equipment**

When cylinders are transported by crane or derrick, a cradle or suitable platform shall be used. When cylinders are transported by means of a magnetic lifting device, the device shall be of the reverse magnet type.

#### **10.8.3.8 Transporting**

Transporting of cylinders by motor vehicle shall be in accordance with the requirements of SANS 10019.

#### **10.8.3.9 Cylinder with regulators attached**

When cylinders are to be moved with regulators attached, the cylinders shall be secured in position on a cylinder trolley and the cylinder valves closed.

### **10.8.4 Cylinder use**

#### **10.8.4.1 Pressure regulator**

Compressed gas shall never be used from cylinders without the pressure being reduced to the maximum allowable working pressure through an approved regulator attached to the cylinder valve or manifold, unless the equipment used is designed to withstand full cylinder pressure.

#### **10.8.4.2 Maximum acetylene pressure**

Acetylene shall not be utilized at a pressure exceeding 150 kPa (gauge).

**Amdt 1**

#### **10.8.4.3 Cleaning cylinder valves**

Before a regulator is connected to a cylinder valve, the valve outlet shall be wiped with a clean cloth free of oil and lint, and the valve shall be "snifted" by being opened momentarily and then immediately closed. This action is intended to clear the valve of dust or dirt that otherwise might enter the regulator.

The person who opens the valve shall stand to one side of the outlet, never in front of it. A fuel gas cylinder valve shall never be opened near welding operations, sparks, flames, or other possible sources of ignition.

#### **10.8.4.4 Special procedures for oxygen cylinders**

After the regulator has been attached to the oxygen cylinder, unscrew the regulator pressure adjusting screw until turning freely. Open the cylinder valve slowly until the pointer of the cylinder contents gauge comes to rest. The cylinder valve can then be opened in accordance with the provisions of SANS 10087-1. The person who opens the valve shall stand to one side of the regulator and not in front of the gauge faces.

**Amdt 1**

#### **10.8.4.5 Handwheel-operated valves**

No tools shall be used to open or close cylinder valves that are fitted with handwheels.

#### **10.8.4.6 Spindle keys**

When fuel gas cylinders that are not fitted with handwheels are in use, they shall have a spindle key on the valve such that the gas flow can be turned off quickly in the event of an emergency. In multiple cylinder installations, at least one such spindle key shall always be available for immediate use.

#### **10.8.4.7 Cylinder valves**

Cylinder valves shall be opened not more than two turns.

#### **10.8.4.8 Access to cylinders**

When a cylinder is in use, nothing that could damage the safety device or interfere with the quick closing of the valve shall be placed on top of the cylinder.

#### **10.8.4.9 Securing of cylinders during use**

A suitable cylinder trolley, chain or steadyng device shall be used to prevent cylinders from being knocked over while in use.

#### **10.8.4.10 Cylinder protection**

**Amdt 1**

Cylinders shall either be kept sufficiently far away from actual welding or cutting operations so that sparks, hot slag or flame cannot reach them, or fire-resistant shields shall be provided (see also 7.3.1).

**10.8.4.11 Electric circuits**

Cylinders shall not be placed where they might become part of an electric circuit. Contacts with third rails, trolley wires, etc., shall be avoided. Cylinders shall be kept away from radiators, piping systems, layout tables, etc., that may be used for machines. An arc shall not be struck on cylinders, since arc-damaged cylinders can leak or explode.

**10.8.4.12 Fuel gas cylinder withdrawal rates**

Withdrawal rates from fuel gas cylinders shall not exceed the manufacturer's recommendations. In the case of acetylene, maximum withdrawal shall not exceed 20 % of the cylinder contents per hour.

**10.8.4.13 Completion of work**

On completion of the work, cylinder valves shall be closed and regulators and lines de-pressurized.

**10.8.5 Cylinder emergencies****10.8.5.1 Valve gland leak**

If a leak is found around the valve spindle stem of a cylinder, the gland nut shall be tightened, or the cylinder valve closed. Leaks can lead to the accumulation of explosive mixtures in confined spaces.

**10.8.5.2 Gas leaks that cannot be stopped**

If tightening of the gland nut does not stop a valve spindle stem leak, or if a valve is leaking at the seal and the leak cannot be stopped by means of closing the valve firmly, or if a leak has developed at the cylinder fusible plug or other safety device, then the cylinder shall be moved to a safe location or outdoors, away from any source of ignition, shall be clearly marked as faulty, and the supplier advised. A warning sign should be posted advising people not to approach the cylinder.

**10.8.5.3 Fuel gas cylinder fires**

If small fires occur at fuel gas cylinders, usually as a result of ignition of the leaks described in 10.8.5.1 and 10.8.5.2, an attempt should be made to extinguish them by closing the cylinder valve or by the use of water, wet cloths, or a fire extinguisher. The leaks should then be treated as described in 10.8.5.1 or 10.8.5.2, as applicable.

In the case of a large fire at a fuel gas cylinder, such as from the malfunctioning of a fusible plug or safety device, personnel should be evacuated from the area, and the cylinder kept cool with a heavy stream of water sprayed from a safe distance.

If circumstances permit, the cylinder fire should be allowed to burn out before an attempt is made to move the cylinder. If the cylinder is located where the fire could cause additional hazards, attempts may be made to move the cylinder to a safer location, preferably outdoors.

Personnel should remain at a distance, and the cylinder should be kept cool by spraying it with a stream of water.

**10.9 Cylinder manifolding****10.9.1 Approval**

Fuel gas manifolds, and their installation and use shall be approved by the local fire prevention officer as required by local municipal bylaws.

**Amdt 1**

### **10.9.2 Fuel gas service**

All manifolds and parts shall be used only for the gases for which they are approved. Any changes to gas service will require re-approval (see 10.9.1).

### **10.9.3 Liquified petroleum gas (LPG) manifolds**

LPG manifold capacity and location shall be in accordance with the requirements of SANS10087-1.

## **11 Arc welding and cutting equipment safety**

### **11.1 Equipment and personnel**

#### **11.1.1 Equipment**

Arc welding and cutting equipment shall be selected in accordance with 11.2, and shall be installed in accordance with 11.3.

#### **11.1.2 Personnel**

Personnel in charge of the equipment or designated to operate the arc welding and cutting equipment shall have been trained and be competent to maintain and operate such equipment.

Regulations and instructions covering the operation and maintenance of the arc welding and cutting equipment shall be readily available at all times.

### **11.2 Safety aspects in selection of arc welding equipment**

#### **11.2.1 Safety standards**

The safety aspects of arc welding shall be considered in the choice of arc welding equipment for the job to be done. Only transformer type arc welding equipment complying with the requirements of the approved standard (as given in annex A) shall be selected. Special purpose machines not covered by the above standards shall conform in all aspects to the provisions set forth in this standard.

**Amdt 1**

#### **11.2.2 Environmental conditions**

When welding or cutting is to be carried out with shielded metal arc welding electrodes, using a.c. or single-phase transformer-rectifier arc welding machines and under conditions that are electrically hazardous due to the presence of water or perspiration, the welding operator shall take special care to prevent electric shock by wearing dry gloves, clothing in good condition, and electrical hazard footwear, and by avoiding accidental contact with live parts.

If a significant amount of work time is spent in electrically hazardous conditions, the use of automatic controls is recommended to reduce the no-load r.m.s. voltage to a value not exceeding 25 V or 30 V d.c. at rated input voltage.

This also applies to 11.2.3.1.

#### **11.2.3 Other conditions**

##### **11.2.3.1 Open-circuit voltage (special processes)**

When special welding and cutting processes require open-circuit voltages exceeding those specified in the approved standard (as given in annex A), adequate insulation or other means shall be provided to protect the operator from making accidental contact with the high voltage.

**Amdt 1**

**11.2.3.2 Work terminal to earthed enclosure**

If a welding lead terminal, intended to be used exclusively for connection to the work, is connected to the earthed power source enclosure, a conductor smaller in diameter (by at least two wire gauges) than the earthing conductor shall be used, and the terminal shall be marked to indicate that it is earthed. Terminals for welding leads shall be protected to eliminate accidental contact with persons or with metal objects such as vehicles or crank hooks.

**11.2.3.3 Portable control devices**

No connections for portable control devices, such as push buttons intended to be carried by the operator, shall be connected to an a.c. circuit rated higher than 250 V. Exposed metal parts of portable control devices operating on circuits rated higher than 50 V shall be earthed by an earthing conductor on the control cable.

**11.2.3.4 Autotransformers**

Autotransformers or a.c. reactors shall not be used to draw welding current direct from any primary a.c. power source that has a rated voltage exceeding 80 V.

**11.2.3.5 Equipment loading**

Welding machines shall not be operated above the ampere ratings and corresponding rated duty cycles specified by the manufacturer and shall not be used for applications other than those specified by the manufacturer.

**11.2.3.6 Welding cables**

Welding cables shall be of the flexible type designed especially for the rigours of welding service and shall be of a size adequate for reasonably expected current and duty cycles. Special attention shall be paid to the insulation of cables used with equipment that includes high-voltage high-frequency oscillators.

**11.2.3.7 Electromagnetic field effects**

Arc welding and cutting produce intense electromagnetic fields which may affect electronic prostheses such as pacemakers. Welding personnel with such implants should consult medical practitioners to establish whether they can expect health risks when exposed to such welding environments. (See AWS Fact Sheet 16 for more information).

High frequency (HF) arc starting modules can also be a source of health concerns regarding electromagnetic field effects on medical devices. Furthermore, HF signals may also effect the operation of sensitive safety critical electronic equipment such as gas monitors if such devices are not adequately screened.

**Amdt 4**

**11.3 Installation of arc welding equipment****11.3.1 Requirements**

Installation, including earthing, necessary disconnects, fuses and the type of incoming power lines shall be in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword).

**Amdt 4**

**11.3.2 The workpiece**

The workpiece on which the welder is working shall be earthed to a good electrical earth unless the competent person is sure that it is safe to work on an unearthing workpiece.

#### 11.3.2.1 Welding current return

Welding current should be returned to the welding machine by a single cable connecting the workpiece to the welding machine.

However, connection of a cable from the welding machine to a common conductor or properly bonded structure on which the work rests, or to which the work is connected, is a permissible alternative procedure. The single cable shall be of a size suitable for the current rating of at least one machine. (See 11.3.6 for voltages and shock hazards.)

#### 11.3.3 Conduit and pipeline earth limitations

Conduits containing electrical conductors shall not be used for completing a work lead circuit. Pipelines shall not be used as a permanent part of a welding circuit, but may be used during construction, extension or repair, provided that the current is not carried through threaded joints, flanged bolted joints or caulked joints. In addition, special precautions shall be taken to prevent the connection of the work lead cable from sparking. For other precautions, see 11.4.1.

#### 11.3.4 Prohibited work lead connection

Chains, wire ropes, cranes, hoists and elevators shall not be used to carry welding current.

#### 11.3.5 Electrical continuity in structures

When, during construction or modification, a building or any other fabricated metal structure is used for a welding current return circuit, it shall be ensured that proper electrical contact exists at all joints. Sparking or heating at any point shall be cause for rejection of the structure as a return circuit.

#### 11.3.6 Connections to minimize shock hazard

Where welders are working close to one another on the same structure, and it is possible to touch the exposed parts of more than one electrode holder simultaneously, machines shall be connected as follows in order to minimize shock hazard:

- a) **d.c. machines:** unless otherwise required in (c) below, all d.c. machines shall be connected with the same polarity. A test lamp or voltmeter can be used to determine if the connections are correct.
- b) **a.c. machines:** unless otherwise required in (c) below, all single-phase a.c. machines shall be connected to the same phase of the supply circuit and with the same instantaneous polarity. A voltmeter can be used to determine if the connections are correct.
- c) **special cases:** in operations involving several welding machines on one structure, the d.c. welding process requirements may require the use of both polarities, or supply circuit limitations for a.c. welding may require distribution of machines among the phases of the supply circuit. In such cases, no-load voltages between electrode holders will be twice the normal voltage in d.c. machines or 1x; 1,41x; 1,73x; or 2x the normal voltage in a.c. machines. Similar voltage differences will exist if both a.c. and d.c. welding is done on the same structure. In these cases, every effort shall be made to instruct the operator and other area personnel of the importance of avoiding simultaneous contact of the exposed parts of more than one electrode holder.

## **11.4 Operation**

NOTE This clause applies to all arc welding and cutting processes.

### **11.4.1 Checking connections**

After any connection to the machine has been assembled, each assembled connection shall be checked before operations are started, to ensure that the connection has been properly made. In addition, the work lead shall be firmly attached to the work; magnetic work clamps shall be freed from adherent metal particles and spatter on contact surfaces. Coiled welding cable should be uncoiled before use to avoid overheating and damage to insulation. Jobs that require the alternate use of long and short cables should be equipped with insulated connectors so that idle lengths can be disconnected when not required.

### **11.4.2 Machine frame earthing**

Before welding machine frames are used, special attention shall be given to ensure that they are earthed in accordance with the manufacturer's instructions.

### **11.4.3 Leaks**

There shall be no leaks of cooling water, shielding gas or engine fuel such as could adversely affect the welder's safety.

### **11.4.4 Safe operating instructions**

Written regulations and instructions covering the safe operation of equipment shall be made available to the welder and shall be strictly followed.

### **11.4.5 Work interruptions**

When the welder has to leave his work or stop for any appreciable time, the machine shall be turned off to de-energize the electrode holder.

### **11.4.6 Moving the machine**

When the machine is to be moved, the input power supply to the equipment shall be electrically disconnected.

### **11.4.7 Equipment not in use**

When not in use, metal and carbon electrodes shall be removed from holders to eliminate danger of electrical contact with persons or conducting objects. When not in use, electrode holders shall be so placed that they cannot make electrical contact with persons, conducting objects, flammable liquids or compressed gas cylinders. When not in use, guns of semi-automatic welding machines shall be so placed that the gun switch cannot be operated accidentally.

### **11.4.8 Electric shock**

#### **11.4.8.1 General**

Avoidance of electric shock is largely within the control of the welder; therefore, it is especially important that a welder has received instruction, and knows how to avoid shock. Safe procedures shall be observed at all times when welders are working with equipment using voltages necessary for arc welding.

#### **11.4.8.2 Live metal parts**

A welder shall never permit the live metal parts of an electrode or holder to touch bare skin or any wet clothing.

**Amdt 1**

#### **11.4.8.3 Insulation**

Welders shall use dry insulating material to protect themselves from electrical contact with the work or ground; particularly, they shall protect themselves against large area contacts by using insulation when they are working in a sitting or prone position.

#### **11.4.8.4 Gloves**

Adequately dry gloves in good condition shall be used.

#### **11.4.8.5 Electrode holders**

Electrode holders shall be well insulated and kept in good repair.

#### **11.4.8.6 Water immersion**

Electrode holders shall not be cooled by immersion in water.

#### **11.4.8.7 Water-cooled holders**

Water-cooled holders and guns shall not be used if there is a water leak or condensation that would adversely affect the welder's safety.

#### **11.4.8.8 Changing electrodes**

The welding machines that supply power to the arc shall always have the output electrically de-energized when tungsten electrodes are changed in gas tungsten arc electrode holders.

#### **11.4.8.9 Other practices to avoid**

The welder shall not coil or loop welding electrode cable around parts of his body. Precautions should be taken to prevent shock-induced falls when the welder is working above ground level.

Whenever possible, the welder shall connect the earthing conductor directly to the parts being joined and not to the general structure.

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### **11.5 Maintenance**

#### **11.5.1 General**

All arc welding equipment shall be maintained in safe working order at all times. The welder or maintenance personnel shall report any equipment defect or safety hazard to the supervisor, and the use of such equipment shall be discontinued until its safety has been assured. Repairs shall be made by competent personnel only.

#### **11.5.2 Welding equipment**

Arc welding equipment shall be maintained in good mechanical and electrical condition to avoid unnecessary hazards.

#### **11.5.3 Equipment used outdoors**

Welding equipment used outdoors shall be protected from inclement weather conditions.

#### **11.5.4 Modifications**

When it is necessary to modify equipment in order to meet noise level requirements, it shall be ensured that the modifications or additions to the equipment do not cause the electrical or mechanical ratings of the equipment to be exceeded or overloaded. Modifications should only be performed by the equipment manufacturer or a competent service technician.

#### **11.5.5 Welding cables**

Welding cables shall be inspected for wear or damage. Cables with damaged insulation or damaged connectors shall be replaced or repaired to achieve the mechanical strength, insulating quality, electrical conductivity and watertightness of the original cable.

#### **11.5.6 Compressed gases**

Use of compressed gases for shielding in arc welding operations shall conform to the applicable provisions of clause 10.

### **12 Resistance welding safety**

#### **12.1 Operator training**

Workers designated to operate resistance welding equipment shall have been properly instructed and judged competent by their employer to operate such equipment.

#### **12.2 Guarding**

##### **12.2.1 Control initiating devices**

Control initiating devices (such as push buttons, foot switches, and retraction and dual-sequence switches on portable guns) on any welding equipment shall be arranged or guarded to prevent the operator from inadvertently activating them.

##### **12.2.2 Stationary equipment**

###### **12.2.2.1 General**

All chains, gears, operating linkages and belts associated with welding equipment shall be protected in accordance with the regulations promulgated in terms of the relevant national legislation (see foreword). Amdt 4

###### **12.2.2.2 Single ram and single point equipment**

On stationary single ram welding machines, both of the operator's hands shall be protected from injury by one of, or a combination of, the following:

- a) machine guards or fixtures that prevent the operator's hands from passing under the point of operation;
- b) two-handed controls;
- c) latches;
- d) presence-sensing devices;
- e) any similar device or mechanism that prevents operation of the ram while the operator's hands are under the point of operation.

### 12.2.2.3 Multi-gun equipment

All multi-gun welding machine operations where the operator's fingers can be expected to pass under the point of operation shall be effectively guarded by the use of a device such as, but not limited to, presence-sensing devices, latches, blocks, barriers or two-handed controls.

### 12.2.3 Portable equipment

#### 12.2.3.1 Support system safety

All suspended portable welding gun equipment, with the exception of the gun assembly, shall be equipped with a support system capable of supporting the total impact load in the event of failure of any component of the suspended system. The support system shall be designed to fail to safety. The use of devices such as cables, chains or clamps is considered satisfactory.

#### 12.2.3.2 Moving holder

Where it enters the gun frame, the moving holder mechanism shall be so designed as to present no shear points to the fingers placed on the operating moving holder; otherwise guarding shall be provided. If suitable guarding cannot be achieved, two handles, one for each hand, with one or two operating switches located at appropriate holding points may be used.

These handles and operating switches shall be sufficiently remote from the shear or pinch point, or both, to eliminate the possibility of any of the operator's fingers entering the shear or pinch point when his hands are on the controls.

## 12.3 Electrical

### 12.3.1 Voltage

All external weld-initiating control circuits shall operate at an r.m.s. voltage not exceeding 250 V for stationary equipment and not exceeding an r.m.s. voltage of 25 V for portable equipment.

#### 12.3.2 Capacitors

Resistance welding equipment and control panels containing capacitors used for stored energy resistance welding that involves high r.m.s. voltages (over 550 V) shall have suitable insulation and shall be protected by complete enclosures, all doors of which shall be provided with suitable interlocks and contacts wired into the control circuit (similar to elevator interlocks). Such interlocks or contacts shall be so designed as to effectively interrupt power and short-circuit all capacitors when the door panel is open.

A manually operated switch or suitable positive device shall be installed in addition to the mechanical interlocks or contacts, as an added safety measure ensuring absolute discharge of all capacitors.

### 12.3.3 Locks and interlocks

#### 12.3.3.1 Doors

All doors and access panels of all resistance welding machines and all control panels that are accessible at production floor level shall be kept locked or interlocked to prevent access to live parts of the equipment by unauthorized persons.

#### **12.3.3.2 Remotely located control panels**

Control panels located on overhead platforms or in separate rooms shall be either locked, interlocked or guarded by a physical barrier.

The panels shall be closed when the equipment is not being serviced.

#### **12.3.4 Spark shields**

Protection shall be provided from the hazard resulting from flying sparks by methods such as the installation of a guard of suitable fire-resistant material or the use of approved personal protective eye wear (see clause 5). The variations in resistance welding operations are such that each installation shall be evaluated individually.

For flash welding equipment, flash guards of suitable fire-resistant material shall be provided to control flying sparks and molten metal. Precautions shall be taken to avoid fires (see clause 7).

#### **12.3.5 Stop buttons**

One or more emergency stop buttons shall be provided on all welding machines

- a) that require three or more seconds to complete a sequence,
- b) that have mechanical movements that could be hazardous to persons if guards were to be removed, and
- c) where the installation and use of emergency stop buttons will not in themselves create additional hazards to persons.

#### **12.3.6 Earthing**

The welding transformer secondary circuit shall be earthed by one of the methods in (a) or (b) below or equivalent protection shall be provided as in (c) below:

- a) permanently earthing the welding secondary circuit;
- b) connecting an earthing reactor across the secondary winding with reactor tap(s) to ground; or
- c) on non-portable machines, arranging for an isolation contactor to open both sides of the line to the primary winding of the welding transformer.

### **12.4 Static safety devices**

On large welding machines incorporating a platen, electrically interlocked safety devices such as pins, blocks or latches shall be provided in cases where the platen or the head can move. The devices shall ensure that the energizing circuit is broken and that the device itself will prevent movement of the platen or head under static load. More than one device may be required, varying with machine size or accessibility, but each device alone shall be capable of sustaining the full static load involved.

### **12.5 Ventilation**

Ventilation shall be provided in accordance with clause 6.

### **12.6 Equipment defects**

The operators or maintenance personnel shall report any equipment defects to the supervisor, who shall record such defects. Necessary repairs shall be carried out by competent personnel.

## 13 Electron beam welding safety

### 13.1 General

**13.1.1** The operator of an electron beam welding machine shall be registered with the Department of National Health and Population Development as a radiation worker and shall comply with all relevant regulations.

**13.1.2** The primary potential dangers associated with electron beam welding equipment are

- a) electric shock,
- b) fumes and gases,
- c) noise, and
- d) radiation.

### 13.2 Electric shock

All electron beam welding machines operate with high voltages that can cause fatal injuries.

The equipment shall be installed strictly in accordance with the manufacturer's instructions. All doors and access panels shall be secured against access by unauthorized persons. When servicing of high voltage components is required, an earthing probe shall be used to ensure complete discharge of the components. The earthing probe shall be connected to the high voltage terminal when the high voltage power supply is being serviced.

### 13.3 Fumes and gases

Adequate area ventilation shall be provided to reduce the levels of concentration of any airborne contaminants around the equipment to levels below the permissible threshold limit values (see clause 6).

Contaminants deposited within the chamber during operation can, when disturbed, become airborne and create a possible health hazard to personnel entering the enclosure. An exhausting technique shall be used to ensure that the level of any contaminant is below the threshold limit values given in table 1.

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### 13.4 X-radiation

All electron beam welding equipment shall be installed and operated in compliance with the manufacturer's instructions and a radiation survey carried out before the equipment is put into service.

The following is the maximum allowable exposure dose registered on survey instruments. Readings are expressed in milliroentgens per hour (mR/h):

- a) **controlled area of limited occupancy** (length and frequency of exposure controlled): 2 mR/h at 5 cm from the outside of the shielding;
- b) **controlled area of continuous occupancy** (length and frequency of exposure not controlled): 0,5 mR/h at 5 cm from the outside of the shielding;

c) **uncontrolled area of continuous occupancy** (length and frequency of exposure not controlled): 0,2 mR/h at 5 cm from the outside of the shielding.

In the case of non-vacuum electron beam systems, a radiation enclosure shall be provided to ensure the safety of the operator and other personnel in the vicinity.

### **13.5 Visible radiation**

During the operation of beam welding equipment, direct viewing of the visible radiation can be harmful to the eyes. Eye protection in accordance with clause 5 shall be provided.

## **14 Plasma arc cutting safety**

### **14.1 Potential hazards**

The potential hazards associated with plasma arc cutting are similar to those of most arc welding and cutting processes. These hazards are

- a) electric shock,
- b) fumes and gases,
- c) noise, and
- d) radiation.

Other potential hazards that should be considered are those due to high pressure gas and water systems and orifice gases containing hydrogen.

### **14.2 Electric shock**

Operators shall ensure that the power to the power supplies and to the control circuitry is disconnected before torch parts are replaced.

### **14.3 Fumes and gases**

Adequate ventilation shall be provided to ensure that the levels of concentration of the fumes and gases do not exceed the threshold limit values given in table 1. Amdt 3

### **14.4 Noise**

During plasma arc cutting operations, the noise level shall not exceed the threshold limit values given in table 1. Where cutting operations are mechanized, the noise level can be effectively reduced by means of the water-table or the water-bed system. Amdt 3

### **14.5 Radiation**

Eye protection shall comply with the requirements of SANS 1400. Protective clothing shall be worn during all plasma arc cutting operations as protection against ultra-violet radiation.

## **15 Laser beam welding and cutting safety**

### **15.1 Equipment and methods of operation**

Laser equipment used in the welding and cutting processes and the methods of operation shall be in accordance with the requirements of the Department of National Health and Population Development.

## 15.2 Potential hazards

The potential hazards associated with laser operations are:

- a) eye damage, including burns of the cornea and retina;
- b) skin burns;
- c) respiratory system damage due to the generation of hazardous materials during operation;
- d) electric shock;
- e) chemical hazards;
- f) cryogenic coolants; and
- g) radiation.

## 15.3 Safety glasses

Safety glasses that are substantially transparent to visible light but are opaque to specific laser systems are available. Care shall be taken to ensure that glasses appropriate to the specific laser system are used. Selective filters are available for ruby and other systems and shall be used as required. The use of shaded glasses shall be in accordance with an approved standard. Amdt 1

## 15.4 Skin burns

Skin burns resulting from inadvertent interception of the laser beam can be very deep and very slow to heal. Where practicable, therefore, the laser beam shall be enclosed. This is particularly important in the case of non-visible beams.

## 15.5 Fumes and gases

The least obvious hazard of the laser welding process is the production of fumes and gases. For example, plastics materials used for burn patterns to identify beam shapes in high power CO<sub>2</sub> systems can generate highly toxic vapours. In deep penetration welding, fine particulate fumes can be generated. Adequate ventilation shall be provided (see clause 6).

## 15.6 Electric shock

High voltage and high capacitance storage devices are associated with lasers, therefore the possibilities of lethal shock are always present. Electrical system enclosures shall have interlocks on all access doors and provisions shall be made for the discharging of capacitor banks before the enclosure is entered.

All laser welding equipment shall be appropriately earthed.

## 16 Air carbon arc gouging safety

The safety precautions outlined in clauses 3 to 8 and clause 11 are applicable to the process of air carbon arc gouging.

**Annex A**  
(informative)**National standards for equipment and auxiliary components used in welding and thermal cutting****Table A.1 — National standards for equipment and auxiliary components used in welding and thermal cutting**

Equipment	Country	RSA	Europe	Australia	France
	Standard	SANS	ISO/IEC/EN	AS	NF
Cylinder shut-off valves	199				
Ear protection	1451-1 1451-3 50352-1 50352-1	EN 352-1 EN 352-2		AZ/NZS 1270	
Earthing clamps	1063			1882	
Electrode holders	5827 5829 5183-1 5183-2 8430-1 8430-2 8430-3 60974-11	ISO 5827 ISO 5829 ISO 5183-1 ISO 5183-2 ISO 8430-1 ISO 8430-2 ISO 8430-3 IEC 60974-11 EN 25827			A85-600 A82-106
Gas burner (pre-heat)	50676	ISO 5172 EN 298 EN 676		1853	
Gas cylinders	10019 4706 220 4706 9809-1	ISO 3500 ISO 3807-1 ISO 3807-2 ISO 4705 ISO 4706 ISO 9809-1 EN 12205 EN 1800 EN 13322-1	1777 2030.1 2030.2 2030.4 2764 2873 2874 2875		A49-901-1 A49-901-2 A49-901-3
Hose couplings	3253	ISO 3253 ISO 7289 EN 560 EN 561 EN 1256			
Oxyfuel safety devices	50730-1	ISO 5175 EN 730-1 EN 730-2		1674.1 1674.2	
Pressure gauges		ISO 5171 EN 562			
Pressure regulator (oxy/acetylene)	2503	ISO 2503 ISO 7291 EN 13918			

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Table A.1 (continued)

Equipment	Country	RSA	Europe	Australia	France
	Standard	SANS	ISO/IEC/EN	AS	NF
Pressure regulator (LPG)	1237				
Protective clothing	316	EN 12477	AS/NZS 2161.1 2161.2 2161.3 2161.4 2375		
Respirators	VC 10220 <sup>a</sup> 50132 50133 50134 50135 50137 50141 50142 50143 50148-1 50148-2 50148-3	EN 132-135 EN 137 EN 141-143 EN 145 EN 148-1 EN 148-2 EN 148-3	1715 1716		
Safety goggles and glasses	1404 50169	EN 166 EN 167 EN 168 EN 169 EN 170 EN 171	AS/NZS 1336 1337 1338.1 1338.2 1338.3		
Welding cables	5828 8207 60974-12	ISO 5828 ISO 8205-1 ISO 8205-2 ISO 8205-3 ISO 8207 IEC 60245-6 IEC 60974-12 EN 1327	1995	A82-110 A82-111 C32-102-6	
Welding/cutting torches	60974-7	ISO 5186 EN 50078 IEC 60974-7			
Welding/cutting nozzles		ISO 5172 EN 731 EN 874		A83-011 A84-540	
Welding helmets/lenses	1400		1337		
Welding hoses	3821 8207 12170	ISO 3821 ISO 8207 ISO 12170 ISO 4113 EN 559 EN 1256 EN 1327	1335		
Welding transformers/Powerpacks/ Rectifiers	954 5826 60974-1 60974-5	ISO 5826 ISO 7284 ISO 10656 ISO 12166 IEC 60974-1 IEC 60974-5	1966-1 1966-2 1966-3 3195	A82-000 A82-020 A82-025 A82-041 A82-043 A82-045	

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**Table A.1 (concluded)**

Equipment	Country	Germany	Japan	Norway	UK	USA
	Standard	DIN	JIS	NS	BS	ANSI
Welding transformers/Powerpacks/Rectifiers (concluded)		60974-6 50060	IEC 60974-6 EN 50060 EN 60974-12			A82-048 A82-113
Cylinder shut-off valves						
Ear protection		T8161				
Earthing clamps					951	
Electrode holders		C9302			638-8 4215-2 4215-6 4215-7 4215-15	
Gas burner (pre-heat)					3929 5885-1	
Gas cylinders	4661-1 4661-2 4661-3 4663	B8230 B8241			5430-6 5045-7	
House couplings		B6805				
Oxyfuel safety devices						
Pressure gauges						
Pressure regulator (oxy/acetylene)						/UL 252
Pressure regulator (LPG)		B6803				
Protective clothing				INSTA 675 676 677		
Respirators		T8150				
Safety goggles and glasses		T8141 T8147				
Welding cables		C3404			638-4	
Welding/cutting torches		6802				/UL 123 /UL 147
Welding/cutting nozzles		B6801				
Welding helmets/lenses		T8142				
Welding hoses					8451	
Welding transformers/Powerpacks/Rectifiers	44766-2 44766-3	C9317 C9300			638-4 638-10 4819-1 4819-2	

<sup>a</sup> Compulsory specification for respirators as published by government notice No. R369 gazette No. 25040 of 2003.03.20

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**Annex B**  
(informative)

**Bibliography and list of publishers**

**B.1 Bibliography**

The following codes, standards, specifications, pamphlets and books are included for information only. Enquiries as to the availability and cost of any of these publications should be addressed directly to the publishers.

ACGIH, <i>Document of the threshold limit values and biological exposure indices.</i>	Amdt 3
ACGIH, <i>Industrial Ventilation : A manual of recommended practice.</i>	Amdt 3
AGA XK0101:2001, <i>Purging principles and practice.</i>	Amdt 3
ANSI Z87.1:2003, <i>Practice for occupational/educational eye and face protection.</i>	Amdt 3
ANSI Z88.2:1992, <i>Respiratory protection.</i>	Amdt 3
ANSI Z117.1:2003, <i>Safety requirements for confined spaces.</i>	Amdt 3
ANSI/NFPA 50:2001, <i>Bulk oxygen systems at consumer sites.</i>	Amdt 3
API 2009:2002, <i>Safe welding, cutting and hot work practices in the petroleum and petrochemical industries.</i>	Amdt 3
AWS A3.0:2001, <i>Standard welding terms and definitions, including terms for adhesive bonding, brazing, soldering, thermal cutting, and thermal spraying.</i>	Amdt 3
AWS F1.1:1999, <i>Methods for sampling airborne particulates generated by welding and allied processes.</i>	Amdt 3
AWS F1.2:1999, <i>Laboratory method for measuring fume generation rates and total fume emission of welding and allied processes.</i>	Amdt 3
AWS F2.2:2001, <i>Lens shade selector.</i>	Amdt 3
CGA G7.1:2004, <i>Commodity specification for air.</i>	Amdt 3
CGA P-1:2000, <i>Safe handling of compressed gases in containers.</i>	Amdt 3
ILO: (1972), <i>Accident prevention; a workers' education manual.</i>	
NFPA 50:2001, <i>Bulk oxygen systems at consumer sites.</i>	Amdt 3
NFPA 51B:2003, <i>Fire prevention during welding cutting and other hot work.</i>	Amdt 3
NFPA 306:2003, <i>Control of gas hazards on vessels.</i>	Amdt 3
NFPA 326:1999, <i>Safeguarding of tanks and containers for entry, cleaning or repair.</i>	Amdt 3
NIOSH 78-138, <i>Safety and health in arc welding and gas welding and cutting.</i>	Amdt 3

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NIOSH 80-144, *Certified equipment list*. Amdt 3

NSC, *Accident prevention manual for industrial operations/fundamental of industrial hygiene*.

RWMA, *Resistance welding machine standards*.

UL 252:2003, *Compressed gas regulators*. Amdt 3

UL 551:1999, *Transformer-type arc-welding machines*. Amdt 3

US, OSHA *occupational safety and health standards (29 CFR 1910)*.

US, OSHA *safety and health regulations for construction (29 CFR 1926)*.

SAIW, *Information document on welding and thermal cutting processes-health and safety*.

## **B.2 List of publishers**

ACGIH	American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.	Amdt 3
AGA	American Gas Association, 400 N Capitol Street, NW Washington DC, 20001.	Amdt 3
ANSI	American National Standards Institute, 1819 L Street NW Washington, DC 20036.	Amdt 3
API	American Petroleum Institute, 1220 L Street, NW, Washington DC, 20005.	Amdt 3
ASME	American Society of Mechanical Engineers, Three park Avenue, New York, NY 10016 - 5990.	Amdt 3
ASTM	American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428 – 2959.	Amdt 3
AWS	American Welding Society, 550 N.W. Le-Jeune Road, PO Box 351040, Miami, FL 33126.	Amdt 3
CGA	Compressed Gas Association, 4221 Walney Road, Chantilly VA 20151 – 2923.	Amdt 3
ILO	International labour Organisation, 4, route des Morillons, 1211 Geneva 22, Switzerland.	Amdt 3
MSHA	Mine Safety and Health Administration, 1100 Wilson Boulevard, Arlington, VA 22209 - 3939.	Amdt 3
NEMA	National Electrical Manufacturers Association, 1300 North 17 <sup>th</sup> Street, Rosslyn VA 22209.	Amdt 3
NFPA	National Fire Protection Association, Batterymarch Park, Quincy, MA 02169 – 7471.	Amdt 3
NIOSH	National Institute for Occupational Safety and Health, 200 Independence Avenue, SW Washington DC, 20201.	Amdt 3
NSC	National Safety Council, 1121 Spring Lake Drive Itasca IL 60611.	Amdt 3

OSHA Occupational Safety and Health Administration, 200 Constitution Avenue, NW, Washington, DC 20210.

RWMA Resistance Welder Manufacturers Association, 100 North 20th Street, Philadelphia, PA 19103. **Amdt 3**

SAIW South African Institute of Welding, Western Boulevard, Main Reef Road, City West, Johannesburg.

UL Underwriters Laboratories Incorporated, 333 Pfingsten Road, Northbrook, IL 60062 - 2096. **Amdt 3**

US Superintendent of Documents, US Government Printing Office, 732 North Capital Street, NW Washington DC, 20401. **Amdt 3**

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